

Experimental validation of numerical codes and investigation of fault tolerance protection

Danilo Erricolo

Cliff Curry

Shantanu Dutt

University of Illinois at Chicago

MURI on RF Effects - Department of Defense Grant F-49620-01-1-0436
Presented at the University of Maryland, 8 June 2002

Report Documentation Page			<i>Form Approved OMB No. 0704-0188</i>					
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>								
1. REPORT DATE JUN 2002	2. REPORT TYPE N/A	3. DATES COVERED -						
4. TITLE AND SUBTITLE Experimental validation of numerical codes and investigation of fault tolerance protection			5a. CONTRACT NUMBER					
			5b. GRANT NUMBER					
			5c. PROGRAM ELEMENT NUMBER					
6. AUTHOR(S)			5d. PROJECT NUMBER					
			5e. TASK NUMBER					
			5f. WORK UNIT NUMBER					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of Illinois at Chicago 851 South Morgan St., Chicago, Illinois 60607, USA			8. PERFORMING ORGANIZATION REPORT NUMBER					
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)					
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)					
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited								
13. SUPPLEMENTARY NOTES Presentations given at the First Annual Review Meeting on June 8, 2002 DoD MURI Award F49620-01-1-0436, The original document contains color images.								
14. ABSTRACT								
15. SUBJECT TERMS								
16. SECURITY CLASSIFICATION OF: <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33.33%; padding: 2px;">a. REPORT unclassified</td> <td style="width: 33.33%; padding: 2px;">b. ABSTRACT unclassified</td> <td style="width: 33.33%; padding: 2px;">c. THIS PAGE unclassified</td> </tr> </table>			a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 12	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified						

Purpose of the experiments

Design of simple systems to perform experiments that encompass most of the tasks of the MURI proposal

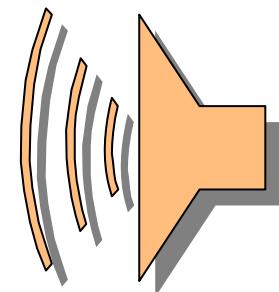
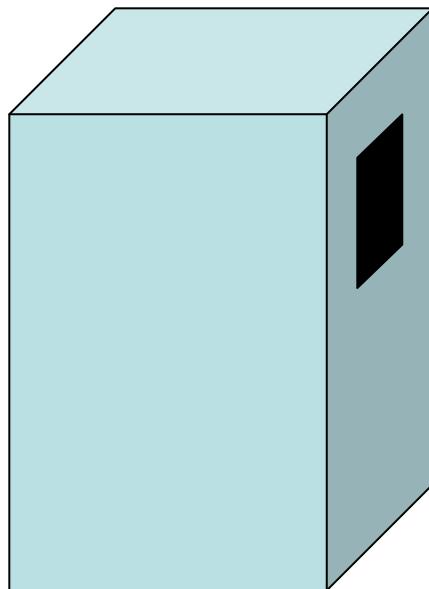
1. Radiation incident on a system
2. Penetration into the system
3. Coupling with internal parts of the system
4. Disturbance of the activity of digital circuits inside the system and assessment of the digital upset

Comparisons with experiments

- The experiments will be paralleled by computer simulations that mimic the chain of events.
- The computer simulations will be performed by the research groups of Dutt, Michielssen and Volakis.

Description of the experiments

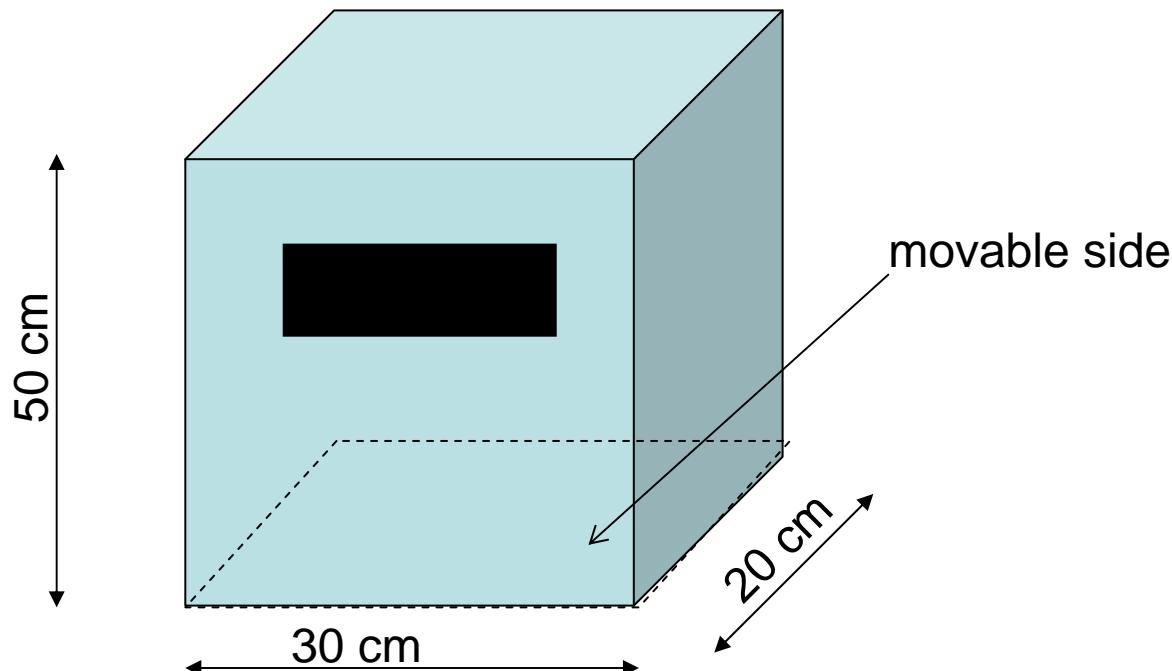
- Illumination of a cavity with an aperture to investigate the effects of the field that penetrates the enclosure.



$1\text{GHz} < f < 5\text{GHz}$

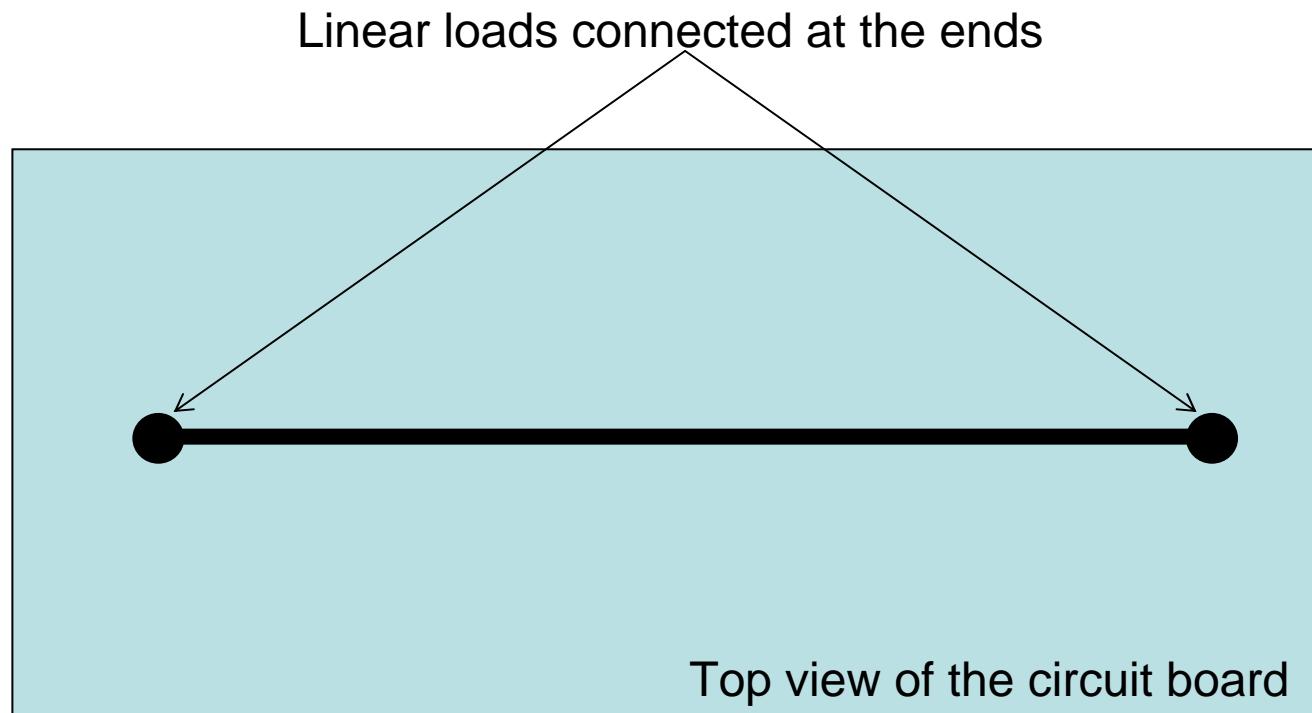
Description of the experiments

- The experiments consider a metallic cavity with an aperture. The size of the cavity is similar to a mini-tower computer chassis. The aperture represents one of the slots found in the back of a computer.



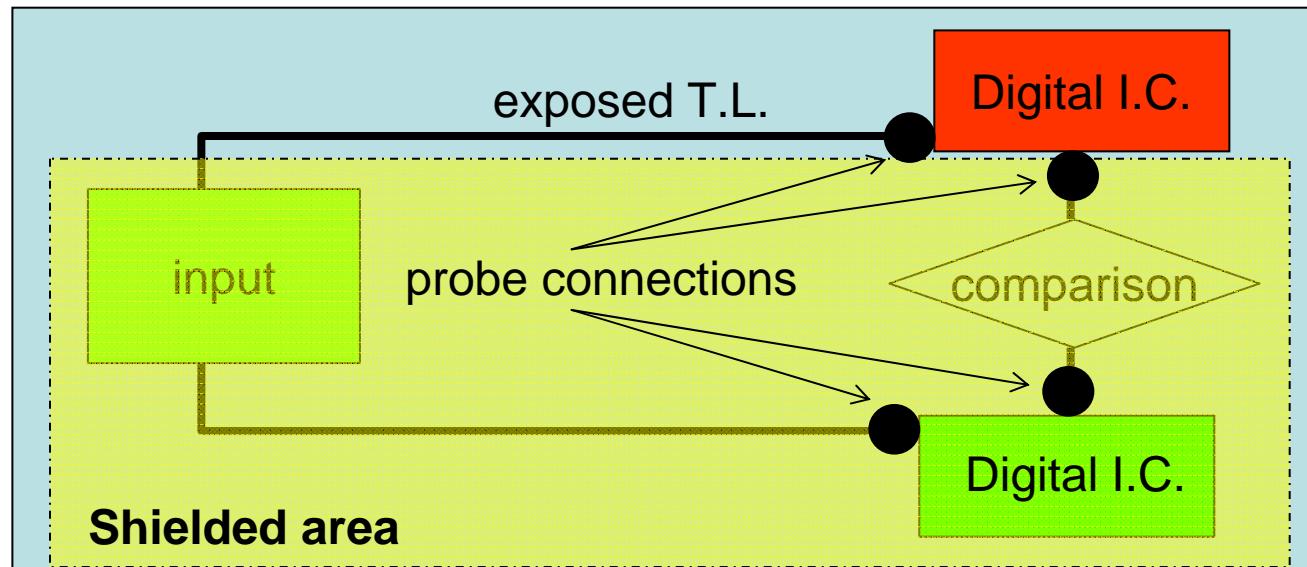
Description of the experiments

- The bottom of the cavity is movable and hosts the device under test (DUT).
 - At the beginning, a simple transmission line is considered.



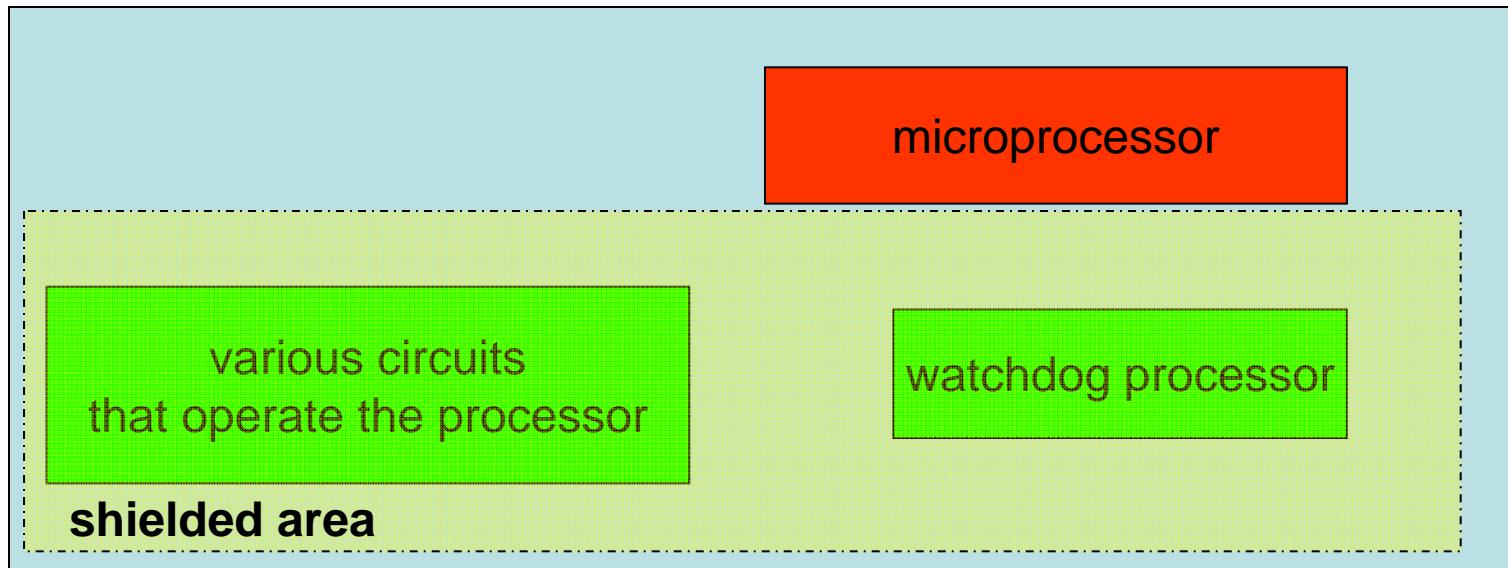
Description of the experiments

- A simple digital circuit connected to some transmission lines and an identical circuit to study its behavior under EMI.



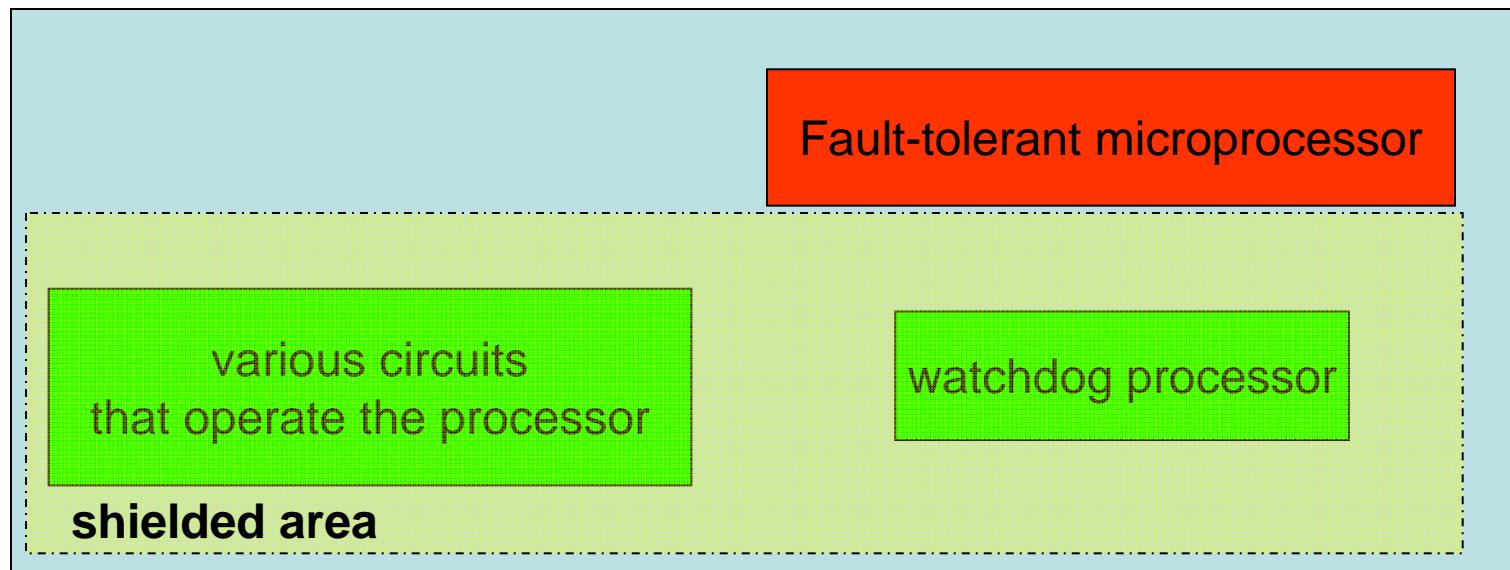
Description of the experiments

A complex digital circuit containing a
basic microprocessor and a watchdog processor



Description of the experiments

A complex digital system containing a
fault-tolerant microprocessor and a
watchdog processor



Description of the experiments

Reduction of the total field inside the cavity

- Introduce damping elements within the cavity (resistors, impedance sheets...)

Additional considerations

- The UIC electromagnetic lab has recently purchased a new fast digital oscilloscope (6GHz bandwidth, 20 Gsample/S) to carry out the measurements (\$60,000).

Extension of the BLT equations

- Studies to extend the BLT equations to incorporate non purely transmission line effects
- The purpose is to study the problem of the field penetrating the cavity through an aperture using the BLT equations and assess their accuracy